SCIENCE:

A WEEKLY NEWSPAPER OF ALL THE ARTS AND SCIENCES

PUBLISHED BY

N. D. C. HODGES,

47 LAFAYETTE PLACE, NEW YORK.

SUBSCRIPTIONS.—United States and Canada................$3.50 a year.

Great Britain and Europe.................. 4.50 a year.

Communications will be welcomed from any quarter. Abstracts of scientific papers are solicited, and twenty copies of the issue containing such will be mailed the author on request in advance. Rejected manuscripts will be returned to the authors only when the requisite amount of postage accompanies the manuscript. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a guaranty of good faith. We do not hold ourselves responsible for any view or opinions expressed in the communications of our correspondents.

Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

CHANGE OF FORM AFFECTING A MAGNETIC FIELD.[1]

HITHERTO the study of a magnetic field has been the study of the so-called lines of force radiating from the poles of magnets, either electro or permanent; and, so far as magnetism has been utilized in the arts, the changes in this external field have been brought about by the movements of an armature, having for its function to determine the direction and consequent density of the field. Such is the case in the instruments used in the telegraph, the telephone, in dynamos, and in motors. Sometimes conducting wires are so mounted in the field that their movement gives rise to electric currents, which signifies that the energy producing the tension in the field is absorbed in some measure by the moving wires, and is transformed into an electric current. In each of these cases the magnet producing the field is stationary; that is, changes in the magnetic field produced by it are due to a motion external to the magnet itself, and may be that of an armature, of a moving wire, or of its own bodily change of position,— a kind which is comparable with what is called external motion in thermo dynamics, to distinguish it from internal motions, or such as take place when the body changes its form. So far as I am aware, no study has been made of the effect of changing the form of a magnetic body on its field, or of the reaction upon itself of its magnetic condition due to a periodic change of form. Of course, it has been known for a long time that the form of the magnetic field depended upon the form of the magnet itself. For a straight bar magnet, this field is familiarly known by the arrangement of iron filings forming curved lines from each pole re-entering the opposite pole. When the iron is bent into a U-form, or horseshoe magnet, the field is mostly contracted to the space between the poles. These forms of magnets have been permanent ones for the purpose for which the magnet was made.

In the case of induction-coils, whether of one form or another, the magnetic change produced by it has been and is due to the electric change produced upon it by an electric circuit provided with intermittent or alternating currents.

Within a few years, attention has been called to the nature of the external field as being a part of what is now known as the magnetic circuit, which consists of these rings or closed circuits of lines of force, all originating in the iron part of the circuit, and for conducting which iron is by far the best. The poles of the magnet are simply the parts of the iron where the lines enter and leave, and they may be in any place. Usually they are at the ends of the iron, but not necessarily so. Whenever iron is placed in the magnetic field, these lines crowd into it, as it is a much better conductor than the ether. When the iron is made into a ring form and then magnetized, there is no external polarity, and consequently no external field, provided that the iron has sufficient conducting cross-section at every part.

The following experiments have been tried, to determine what effects, if any, are produced upon a magnetic field by changing the form of the magnet. It was thought at first, that if a helix was coiled into a circle and a current was present in it, changes in its form would produce corresponding changes in the magnetic field external to the coil, especially noticeable if a flexible iron ring was enclosed in the helix so as to condense the magnetic field. This was put to the test in the following manner.

I. A coil similar to the one described above, but containing a solid ring of iron about eight inches in diameter and an inch thick, had its coil put in circuit with a reflecting galvanometer of low resistance, and at such a distance from it that magnetic fields external to its circuit could not act upon it. Another coil made about a flexible ring of iron wire was put in circuit with a battery, so as to magnetize the ring strongly. Then, with one ring parallel to the other, the flexible one was made suddenly to assume an elliptical form. Each such change in form, from one ellipse to another at right angles to it, gave a deflection of the needle to the right or left, and uniformly for a given phase of change. It was also observed that the direction of the deflection was reversed when the flexible ring was turned the other side up.

II. The same flexible ring, used in the same way, but without the current through it, gave substantially the same results. Of course, the ring was permanently magnetized, and the change might have been inferred.

III. As the same kind of motion, due to change of form, is taking place when a ring is vibrating at its harmonic rate, producing what we call sound-vibrations, it was thought probable that a magnetized ring, having a coil of wire about it in connection with a telephone, would set up vibratory currents when it was struck; and this was found to be true, for, when the coil containing the heavy iron core was put in circuit with a telephone in another room, the sound of the stroke and the pitch of the ring could plainly be heard. In the first case, the number of turns of wire was small, perhaps fifty or thereabouts. I therefore had two larger rings made, each about one foot in diameter and half an inch thick.

IV. One of these was wound with six or seven hundred turns of No. 32 wire. Before it was magnetized, it was connected with the telephone, and tested for its magnetic condition by striking. The ring could plainly be heard, which showed that it had some degree of magnetism.

V. Then about two hundred turns of coarse wire were wound upon it, and a strong current sent through it to magnetize it. After this magnetizing coil had been removed, the ring was again tested as in IV. The sound was very much louder. Indeed, the telephone could be held a foot from the ear and be heard.

VI. With the ring in V. still in circuit, the companion ring, without any wire upon it, was brought near it and struck. The sound was easily heard in the telephone circuit.

VII. This second ring was now magnetized in the same way as the first, when the magnetizing helix was removed, and experiment VI. repeated. The sound was very much louder.

VIII. The ring was now struck and moved away from the first ring by stages of an inch or two at a time. It was found possible to hear its pitch in the second circuit, when it was a yard or more away from it.

IX. As the pitch of the two rings was not quite the same, the higher one was loaded so as to bring them to unison. The sound was then louder and more persistent than before. This gave evidence that it was a case of sympathetic vibration, while the former were forced vibrations.

[1] Paper presented Jan. 14, 1891, by A. Emerson Dolbear, to the American Academy of Arts and Sciences, Boston.